REMARKS

Claims 1-3, 6-7, 11, 15, and 22 are now in this RCE application. Claims 4-5, 13-14, and 16-21 have been cancelled; claims 1-3, 6, 11, and 15 have been amended; and new claim 22 has been added. Attached hereto is a marked-up version of the changes made to the specification and claims by the current amendment. The attached pages are captioned "**Version with marking to show changes made.**"

I. Statement Regarding Order of Amendment Refused Entry in Parent, and Preliminary Amendment Accompanying This RCE Application

The Preliminary Amendment which accompanies this RCE application does not replace the earlier amendment dated January 24, 2003, which was filed in response to the Final Rejection mailed December 24, 2002, and was refused entry in the USPTO Advisory Action mailed February 21, 2003. Although the January 24, 2003 response to the Final Rejection contained no amendments to the claims, it did amend the specification to replace a U.S. Patent Serial No. with an issued U.S. Patent No. Therefore, in accordance with the provisions of 37 C.F.R. 706.07(h)III, section D, Applicants' attorney hereby indicates that the January 24, 2003 response should be considered first with respect to the amendments to page 8 of the specification.

II. **Restriction**

A. **Non-Entry of Applicants' Response After Final Rejection**

With regard to the non-entry of Applicants' January 24, 2003 response, Applicants must call attention to the language of the July 31, 2002 Office Action, on page 3, at lines 13-15, which reads as follows:

"Specification"

"Update U.S. Patent Nos. under the heading; Cross Reference to Related Applications and on pg. 8, last paragraph."

Pursuant to this, Applicants, in their response dated October 31, 2002, amended the last paragraph on page 8 of their specification (11th line of the paragraph) to change Serial No. 09/274,457 to U.S. Patent No. 6,303,047.

In view of this requirement, Applicants, in their response to the Final Rejection dated January 24, 2003, attempted to further amend page 8 of their specification to also change Serial No. 09/590,310 to U.S. Patent 6,365,528. Applicants' January 24, 2003 response contained no changes to the claims.

With regard to non-entry of an amendment after a Final Rejection, in such circumstance, 37 C.F.R. 1.116(b) states:

"After a final rejection or other final action (§1.113), amendments may be made canceling claims ***or complying with any requirement of form expressly set forth in a previous Office action.***" (emphasis added)

Because of the USPTO's earlier requirement in the July 31, 2002 Office Action, as set forth above, and the provisions of 377 C.F.R. 1.116(b), the refusal to enter Applicants' response dated January 24, 2003, is believed to be improper.

B. **The Restriction Issue and Applicants' Alleged Admission that Claims 2, 6, 12, and 13 Are Drawn To a Dual Damascene Structure**

The Final Rejection states that Applicants have admitted on page 12 of their response that claims 2, 6, 12, and 13 are drawn to a dual damascene structure. Not true!! The actual statement, which Applicants made on page 12 of their October 31, 2002 amendment, reads as follows:

> "Attention is invited to amended claim 6 ***which now comprises the limitations of claim 1*** (from which claim 6 formerly depended), claim 2 (which depends from claim 1), and claim 12, (which originally depended from claim 6). The product formed by amended claim 6 may be deemed to be a dual damascene structure in the broadest sense, and certainly practice of the process of claim 13, which now depends from amended claim 12, would result in formation of a dual damascene structure." (emphasis added)

Thus, it can be seen that the "so-called admission" actually refers to claim 1 as well as claims 2, 6, 12, and 13 (not just claims 2, 6, 12, and 13). Therefore, since Applicants have admitted that ***the combination*** of the limitations of claims 1, 2, 6, 12, and 13 may be deemed to be a dual damascene structure, and the USPTO considers this to be an admission which relates to individual claims, claims 1, 2, 6, 12, and 13 must be ***all*** drawn to the non-elected species and must be ***all*** withdrawn. Such an interpretation would leave no claims drawn to the elected species. All claims in one species and none in the other equals no restriction. It should be noted here that such an interpretation is not because Applicants changed the claims to read on the non-elected species. All of the limitations now in amended claim 6 were present in claims 1, 2, 6, 12, or 13 ***of the elected species***. Instead of shifting claims 2-7, 11, and 13-16 into the non-elected species, claims 17-21 should have been shifted into the elected species, thereby dissolving the restriction.

C. **Traversal of Restriction by Petition**

The Advisory Action further advises that Applicants should direct their traversal of the restriction to petitions. A petition is of little value if not acted on by the USPTO in a timely fashion. The restriction, when first made was annoying and (in Applicants' judgment) improper. However, since (in the opinion of Applicants' attorney) the claims in each of two species covered the same invention, Applicants could adequately protect their invention with claims 1-16 of the elected species. Therefore, at a time when a petition could have been filed (together with a petition to suspend prosection), there was no need for such extreme measures. However, now Applicants have been deprived of all but claim 1 in their elected species in a Final Rejection - without any prior notice. Furthermore, to add insult to injury, Applicants have even been denied entry of their sole opportunity to respond to this arbitrary ruling.

With regard to the filing of a petition at this stage of the prosecution, a petition to suspend the prosecution would have to be filed with the petition to review the restriction. Otherwise a decision on the petition regarding the restriction would not be granted in time to have any effect on the prosecution. Such a petition to suspend prosecution, as understood, is not permitted when filed during a period when a response is due in the USPTO. So, in essence, Applicants have been deprived of any opportunity to protest the restriction in the form to which it was altered in the Final Rejection.

III. **Action Being Taken By Applicants To Advance Prosecution**

Despite Applicants' position that the Restriction of the claims between claims 1-16 and claims 17-21 is flawed, Applicants are concurrently filing this RCE application with claims drawn to the species of group I (as understood) and a divisional application with claims drawn to the species of group II (as understood) to advance the prosecution.

A. **Amendments to the Claims**

Applicants have amended their claims to specifically recite the formation of a photoresist mask over the densified layer of dielectric material, from which photoresist mask a hard mask can be replicated in the densified layer of dielectric material. The claims then recite the removal of the photoresist mask after formation of the hard mask, but prior to the etching of openings in the underlying low k dielectric layer through the hard mask. In this manner, the sidewall surfaces of the openings subsequently etched in the low k layer of dielectric material will not be exposed to the harsh oxidizing (ashing) procedures used to remove the photoresist mask.

B. **Declaration Submitted by Common Inventor in Instant Application and Cited Wang et al. Reference**

Enclosed is a Declaration executed by Wilbur G. Catabay, who is one of the joint inventors of the Wang et al. reference as well as a joint inventor of the pending application. In his declaration, Catabay points out that hydrogen present in the reducing plasma in the Wang et al. reference, chemically reacts with the already broken bonds in the low k dielectric material, resulting in the formation of a thin surface which interferes with the passage of further hydrogen into the low k dielectric layer.

The Catabay declaration then points out that the densified layer which results from the practice of the instant invention has a thickness ranging from about 300 Å to about 1000 Å, with a typical thickness of about 500 Å. He then estimates the thickness of the layer formed in the Wang et al. reference, as a result of the chemical reaction between the hydrogen in the plasma and the broken bonds in the low k dielectric layer, to be much less, i.e., less than about 100 Å. It should be noted here that such a thin surface coating may be a requirement in the Wang et al. reference since the damages or broken bonds in Wang et al. are located in the exposed sidewall surfaces of vias which are very small in diameter. Formation of a thicker layer in the Wang et al. vias could interfere with subsequent filling of those vias with metal.

The Catabay Declaration should satisfy the contention in the Advisory Action that Applicants' representative makes assertions without the support of evidence, although Applicants attorney must again challenge the veracity of the allegation made in the Advisory Action. The Advisory Action states that Applicants' attorney has asserted that the claims of Wang et al. will result in undesired moisture on and in the low k insulation material. Applicants' attorney cannot recall making any such statement.

Applicants' attorney has stated that the purpose of the Wang et al. process is to address and remedy (not create) the problem of moisture which results from the breaking of bonds in the low k layer during removal of the resist mask ***after*** etching of the via openings. The Wang et al. inventors did not create this problem as alleged in the Advisory Action. Rather, they fixed the prior art problem by reacting hydrogen with the broken bonds in the layer of low k dielectric material before such broken bonds in the exposed low k sidewalls of the vias have an opportunity to react with moisture.

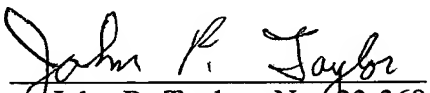
In contrast, Applicants' process eliminates the problem of broken bonds in the low k dielectric material by removing the resist mask before exposing the low k surfaces. The point is not whether Applicants' proposed process is better than the Wang et al. process, but rather that they are not the same nor obvious variants.

Perhaps, in closing, one may borrow from the health sciences to further facilitate an understanding of the basic issue. In the health sciences, two approaches can be taken to solve a particular malady, be it AIDS, the new SARS affliction, or even the common cold: either treat the symptoms or eliminate the source. One may treat the symptoms to alleviate them or at least reduce the adverse effects down to a manageable level. This could be typified as the Wang et al. approach with regard to the problem of broken bonds which react with moisture.

The other approach is to destroy or neutralize the source of the objectionable systems. No one in the primitive stages of medicine knew how to control or treat bubonic plague, but instead mankind discovered and eliminated the source of the problem, "kill the rats"! This is Applicants' approach to the problem of broken low k bonds and resultant moisture bonding to the low k material. Applicants avoid severance of the bonds in the low k dielectric material in the first place by removing the resist mask ***before*** the low k material is exposed by the formation of openings in the low k dielectric material.

Applicants' novel process is not suggested by the Wang et al. teachings. If the Examiner in charge of this case feels that there are any remaining unresolved issues in this case, the Examiner is urged to call the undersigned attorney at the below listed telephone number which is in the Pacific Coast Time Zone.

Respectfully Submitted,



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VERSION WITH MARKINGS TO SHOW CHANGES MADE

In the Specification:

The paragraph beginning at page 10, line 18, has been amended as follows:

Barrier layer 6, formed over integrated circuit structure 2, may comprise a conventional silicon oxide dielectric material or another conventional dielectric material such as silicon nitride, silicon oxynitride, or silicon carbide. ~~Preferably, f~~ From at least the standpoint of adhesion to other layers, it is preferable ~~preferably~~ that barrier layer 6 comprise silicon oxide.

The paragraph beginning at page 11, line 21, has been amended as follows:

Turning now to Figure 3, after removal of resist mask 30, the fluorocarbon/hydrofluorocarbon etch is resumed to etch away any remaining portions of densified layer 20 at the bottom of holes 24 and then to etch holes 14 through low k layer 10 and holes 8 in barrier layer 6 to thereby form a via or contact opening down to underlying integrated circuit structure 2, as shown in Figure 3. Since densified layer 20 is formed from low k dielectric layer 10, there should be no problem of adhesion between low k layer 10 and the densified layer 20. Furthermore, when silicon-based material is used to form barrier layer 6 and low k dielectric layer 10 comprises a silicon oxide-based dielectric material, adhesion problems between barrier layer 6 and low k layer 10 should be minimized as well, thus effectively eliminating adhesion problems between the individual layers making up the compound dielectric layer. Furthermore, the formation of densified layer 20 from low k layer 10 permits a single chamber to be used for the formation of the low k dielectric layer 10 and its subsequent plasma densification treatment to form densified layer 20, thus eliminating time consuming and potentially contaminating movements of the substrate between multiple processing chambers.

The paragraph beginning at page 12, line 11, has been amended as follows:

At this point, as also shown in Figure 4, a capping layer 46, comprising, for example, conventional silicon oxide as used for dielectric barrier layer 6, could be deposited over low k dielectric layer 40 as a protective layer followed by deposition of resist mask 50 over protective capping layer 46 ~~40~~. Capping layer 46 may then be selectively etched through resist mask 50 to form a hard mask in capping layer 46, followed by removal of resist mask 50 before the etching of second low k dielectric layer 40, thereby protecting low k layer 40 from the processing used to remove resist mask 50, as in the previous embodiment. This selective etching of protective capping layer 46 can also be carried out, when capping layer 46 comprises silicon oxide or silicon carbide, using the previously described fluorocarbon/hydrofluorocarbon etch to etch away substantially all of the exposed capping layer 46 beneath resist mask 50.

In the Claims:

Claims 4-5, 13-14, and 16-21 have been cancelled.

Claims 1-3, 6, 11, and 15 have been amended as follows:

1. (Amended) A process for forming an integrated circuit structure having at least one layer of low k dielectric material therein and a layer, formed from said low k dielectric material, suitable for use as an etch stop and/or an etch mask which consists essentially of ~~comprises~~:

a) forming a first layer of low k dielectric material over a previously formed integrated circuit structure; and

b) then, prior to any exposure of said first layer of low k dielectric material to etchants, treating the upper surface of said first layer of low k dielectric material with a plasma formed from a non-oxidizing gas to form a first layer of densified dielectric material over the remainder of the underlying first layer of low k dielectric material;

whereby said first layer of densified dielectric material is capable of serving as a etch stop and/or an etch mask for subsequent etching of said underlying first layer of low k dielectric material.

2. (Amended) The process of claim 1 including the further steps of: ~~step of~~

a) forming a first photoresist mask with a first pattern of openings therein over said first layer of densified dielectric material; and

b) patterning said first layer of densified dielectric material through said first openings in said first photoresist mask to form a first etch mask layer of densified dielectric material having a pattern of openings in said first etch mask layer of densified dielectric material ~~therein~~ suitable for use in etching a corresponding pattern of openings in said underlying first layer of low k dielectric material.

3. (Amended) The process of claim 22 ~~2~~ including the further step of etching said pattern of openings in said first layer of low k dielectric material through said pattern of openings in said first etch mask layer of densified dielectric material thereon.

6. (Amended) A process for forming an integrated circuit structure having at least one layer of low k material therein and a layer, formed from a low k dielectric layer, suitable for use as an etch stop and/or an etch mask which comprises:

a) forming a first layer of low k dielectric material over a previously formed integrated circuit structure; and

b) treating the upper surface of said first layer of low k dielectric material with a plasma formed from a non-oxidizing gas to form a first layer of densified dielectric material over the remainder of the underlying first layer of low k dielectric material whereby said first layer of densified dielectric material is capable of serving as an etch stop and/or an etch mask for etching of said underlying first layer of low k dielectric material;

c) forming a first photoresist mask over said first layer of densified dielectric material;

d) ~~e)~~ patterning said first layer of densified dielectric material through said first photoresist mask to form a first etch mask layer of densified dielectric material having a pattern of openings therein suitable for use in etching a corresponding pattern of openings in said underlying first layer of low k dielectric material;

e) removing said first photoresist mask;

f) ~~d)~~ forming a second layer of low k dielectric material over said first layer of densified dielectric material;

g) ~~e)~~ treating the upper surface of said second layer of low k dielectric material with a plasma formed from a non-oxidizing gas to form a second layer of densified dielectric material over the remainder of said second layer of low k dielectric material;

h) forming a second photoresist mask over said second layer of densified dielectric material;

i) ~~f)~~ patterning said second layer of densified dielectric material through said second photoresist mask to form a second etch mask layer of densified dielectric material over said second layer of low k dielectric material, said second etch mask layer of densified dielectric material having a pattern of openings therein suitable for use in etching a

corresponding pattern of openings in the underlying second layer of low k dielectric material;

j) removing said second photoresist mask;

k) ~~g)~~ etching a pattern of openings in said second layer of low k dielectric material through said pattern of openings in said second etch mask layer;

l) ~~h)~~ forming a pattern of openings in said first etch mask layer of densified dielectric material through said pattern of openings formed in said second layer of low k dielectric material; and

m) ~~i)~~ etching a pattern of openings in said first layer of low k dielectric material through said pattern of openings in said first etch mask layer of densified dielectric material.

11. (Amended) The process of claim 6 including the further steps of:

a) forming a third ~~another~~ etch mask over said second etch mask layer of densified dielectric material, said third ~~another~~ mask having openings larger than the openings in said pattern of openings in said second etch mask layer; and

b) etching said larger openings through:

i) said second etch mask layer of densified dielectric material; and

ii) said second layer of low k dielectric material;

down to said first etch mask layer of densified dielectric material;

whereby said structure will have a pattern of smaller openings formed in said first layer of low k dielectric material and a pattern of larger openings formed in said second layer of low k dielectric material and generally in registry with said pattern of smaller openings.

15. (Amended) The process of claim 22 ~~2~~ including the further steps of:

a) forming a second layer of low k dielectric material over said first layer of densified dielectric material;

b) treating the upper surface of said second layer of low k dielectric material with a plasma formed from a non-oxidizing gas to form a second layer of densified dielectric material over the remainder of said second layer of low k dielectric material; and

c) forming a second photoresist etch mask over said second layer of densified dielectric material;

d) patterning said second layer of densified dielectric material through said second photoresist mask to form a second etch mask layer of densified dielectric material over said second layer of low k dielectric material; and

e) then removing said second photoresist mask;

said second etch mask layer of densified dielectric material having a pattern of openings therein comprising openings larger than said openings in said first etch mask layer of densified material, said openings in said second etch mask layer of densified dielectric material in registry with said openings in said first etch mask layer of densified dielectric material.